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Design and Implementation of a Dual Axis Solar Tracking System

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***Abstract*— Population of the world is getting increased rapidly day by day and the demand for energy is increasing appropriately. During the recent decades, the main sources of energy such as the Oil and coal are expected to end up from the world. This ends up in a serious problem for providing the world with the most affordable and reliable source of energy. All the people in the world needs the renewable energy resources which has cheap costs. Solar energy is appraised as one of the main energy resources in warm countries. For most of the time, India has relatively very long sunny days for more than half of the year. This makes the desert areas in the west like Rajasthan, Gujarat, etc. to be highly rich are solar energy resource. Many papers have been proposed using photovoltaic cells but they did not take into account the difference of angle of incidence of the sun by providing the solar panels in a fixed orientation which influences very highly the solar energy which is been collected by the panel. In this paper we propose a methodology by which it is possible to conserve full amount of power produced by the solar panel by receiving the high intensity sun light using Arduino board.**

***Keywords*—Dual axis solar tracker, Arduino board, LDR Sensors, Servo motor**

I. INTRODUCTION

Solar energy is quickly gaining additional importance in increasing the renewable energy resources. This energy has the large risk of conversion into power. This proposed paper is initiated to vanquish the loss in power generation on the solar battery. this may be done by succeeding the high intensity of the sunshine created by the sun rays. The solar battery is machine-controlled to follow the purpose of high intensity of the daylight victimization LDR (light dependent resistor) sensors. This sensing element helps to sense the extreme temperature created by the sun lightweight on the panel surface and it is sent to the microcontroller. This device sends the feedback to the servo motor that permits the servo motor to rotate the panel to receive the high intensity of the daylight. By this overall strategy, it is doable to conserve full quantity of power created by the solar battery by receiving the high intensity sun light.

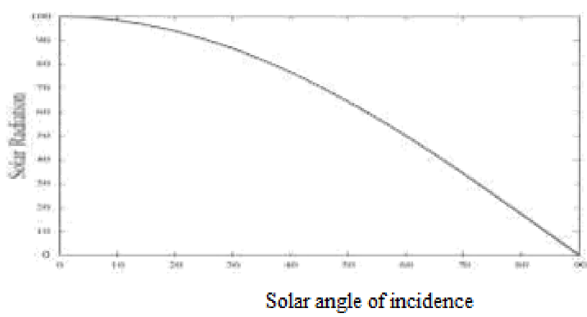

Fig.1. Curve for the relationship between the solar radiation and the solar angle of incidence.

II. DESIGNING A SOLAR TRACKER

The Solar tracking system consists of the following main parts.

Arduino board-Used to control the Servo motor.

LDR sensor-Used to detect the high intensity of the sun light.

Servo motor-Used to rotate the solar panel in order to receive the high intensity.

Solar panel-To convert the light energy to electrical energy.

The electrical system consists of LDR sensors which provide feedback to a micro controller. This micro controller processes the sensor input and provides two PWM signals for the movement of servo motors. This servo motor moves the solar panel towards the higher density of solar light. The entire electrical system is powered by a 12volt source power supply. Initially five different analog values are obtained from LDR's, and then they are feed to microcontroller. Micro controller gives two different PWM signal for the movement of solar panel through servo motor.

A. Solar Trackers

Solar tracker may be a device that follows the movement of the sun because it rotates from the east to the west on a daily routine. Prior to everything, all systems need to supply one or 2 degrees of freedom in movement. Trackers square measure keeps solar panels orienting directly towards the sun because it moves through the sky each day. These solar trackers will increase the number of solar power that is received by the solar power collector and improves the energy output of the heat/electricity that is generated. Solar trackers will increase the output of solar arrays by 20-30% that improves the political economy of the solar panel applications. There are two types of solar tracking systems which are commonly being used. They are as follows:

B Passive Tracking Systems

The passive tracking system realizes the movement of the system by utilizing a low boiling point liquid. This liquid is vaporized by the added heat of the sun and the center of mass is shifted leading to that the system finds the new equilibrium position of the sun.

C. Active Tracking Systems

The two basic types of active solar tracker are single-axis and double-axis. Here we are using Dual axis tracking system. Dual axis tracker as shown in the Fig.2 have two degrees of freedom that act as axes of rotation.

Fig.2. Dual axis tracker

Double-axis solar trackers, as the same suggest, can rotate simultaneously in horizontal and vertical directions, and so are able to point exactly at the sun at all times in any location. Dual axis tracking systems realize movement both along the elevation- and azimuthally axes. These tracking systems naturally provide the best performance, given that the components have high enough accuracy as well.

D. Sensors

Here in Fig.3, we use Light Dependent Resistor's as a sensor. They sense the higher density area of sun light. The solar panel moves to the high light density area through servo motors. Each LDR is connected to power supply forming a potential divider. Thus any change in light density is proportional to the change in voltage across the LDR's.

Fig.3. Pair of LDR sensors

E. Arduino Board

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; so, simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery. The Arduino integrated development environment (IDE) is a cross-platform application written in Java, and derives from the IDE for the Processing programming language and the Wiring projects. It is designed to

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introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click.

F. Dc Servo Motors

DC motors have a very gradual acceleration and deceleration curves, therefore stabilization is slow. The only way to effectively use a DC motor for precise positioning is to use a servo. The servomotor is actually an assembly of four things: a normal DC motor, a gear reduction unit, a position-sensing device (usually a potentiometer), and a control circuit. The function of the servo is to receive a control signal that represents a desired output position of the servo shaft, and apply power to its DC motor until its shaft turns to that position.

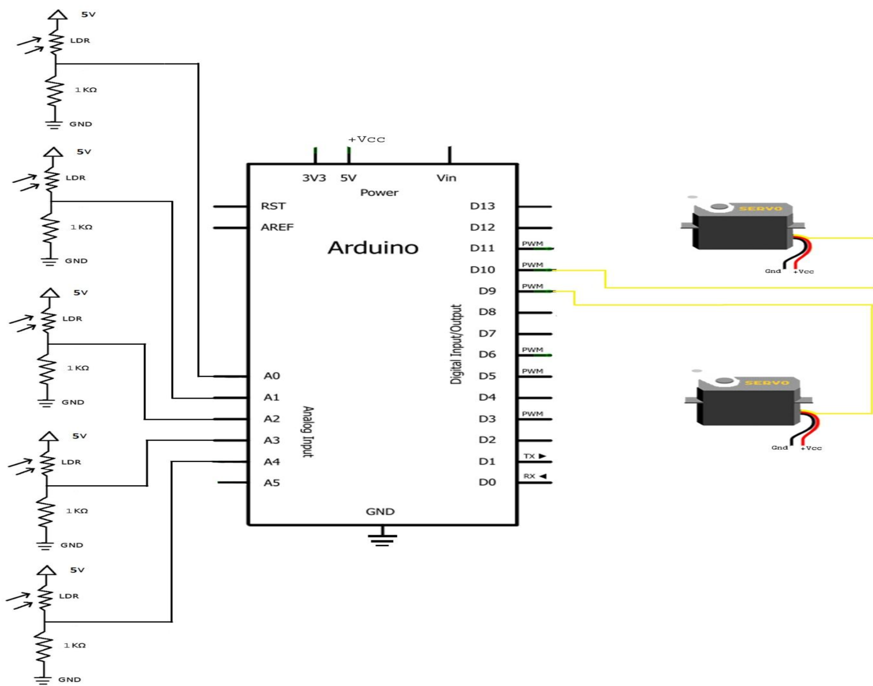

Fig.4. Arduino Board connection

III. WORKING METHODOLOGY

To develop this dual axis tracking system, a sensor named as light dependent resistor (LDR) is used. The resistance of these LDR sensors decreases when the intensity of light increases. Two 12 volt full geared stepper motors are used here for rotating the solar five LDR sensors for detecting the light intensity. To track the sun movement accurately dual axis tracking system is necessary. The sun always faces the panel and so the greatest maximum energy can be absorbed as the panel operates at its greatest efficiency. The main aim of this paper is to improve the power gain by accurate tracking of the sun. The daily movement of the sun causes it to appear in east to west direction over the earth whereas the annual motion causes the sun to tilt at an angle of 23.5 degrees while moving along east-west direction. So the maximum efficiency of the solar panel is not being used by single axis tracking system. In this paper, L293D is used for binary data into mechanical data. Two pair of light dependent resistors (LDR) is used as sensors to track the sun's exact position.

One pair senses the position of the sun in vertical axis i.e. from the east and west side and other pair senses in the horizontal axis i.e. from the north and south side. This sensor information is then passed to the light comparison unit. The rest LDR senses the night mode and then the signal will be sent to the light comparison unit.

A light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity. Microcontroller is the main control unit of this whole system. The output from the light comparison unit comes to the input of the microcontroller which determines the direction of the movement of the motors both in the horizontal and vertical axes. For this paper Arduino microcontroller is use. The design of the light sensor is based on the use of the shadow. If the Photo Voltaic panel is not perpendicular to the sunlight, the shadow of the cylinder will cover one or two LDRs and this causes different light intensity to be received by the sensing device. Thus, the design of a dual axis solar tracker is done and can obtain the energy from the sun very efficiently.

IV. IMPORTANCE AND BENEFITS OF SOLAR TRACKER

The Solar tracking systems are used to continually orient photovoltaic panels towards the sun and can help maximize your investment in your PV system. They are beneficial as the sun's position in the sky. Solar trackers generate more electricity than their stationary counterparts due to an increased direct exposure to solar rays. There are many different kinds of solar tracker, such as single-axis and dual-axis trackers, which can help you find the perfect fit for your unique jobsite. Installation size, local weather, degree of latitude, and electrical requirements are all important considerations that can influence the type of solar tracker that’s best for you. Solar trackers generate more electricity in roughly the same amount of space needed for fixed tilt systems, making them ideal optimizing land usage. Another very important aspect to emphasize is that thanks to solar tracking not only the production of energy increases, but also improves the way the power output is delivered. With solar tracking you can extend the time of available maximum power and thus produce with greater capacity more hours a day.

V. CONCLUSION

The empirical findings lead us to believe that the research work may provide some contributions to the development of solar energy applications. (1) a simple and cost- effective control implementation, (2) an autonomous PV inverter to power the entire system, (3) ability to move the two axes concurrently within their respective limits, (4) ability to balance the tracking accuracy, and (5) applicable to moving platforms with the Sun tracker. In this paper a dual axis sun tracking system has been successfully designed, built and tested. It allows the sun’s path from morning to evening and then gets back to the initial position facing towards east side. So the system reserves a lot of energy by keeping the motors off during night time. This technology of tracking is very easy and simple in design, reduced in cost and precise in tracking. A variety of technologies for the solar energy are available on the market. But this tracking technology which is based on dual axis has higher energy gain comparing with both fixed solar panel and single axis solar tracking technologies and it is also very efficient.

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